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College Park, Maryland

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FISH AND WILDLIFE SERVICE - - - - - - - - - - - - - - - - - IRA N. GABRIELSON, DIRECTOR

A SERIAL memorandum published occasionally for the advancement of fish-culture and fishery management in fresh waters.

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(Continued on inside back cover)

The PROGRESSIVE FISH-CULTURIST

News and Views from many Sources on Practical Hatchery Problems

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WAR AND THE P.F.C.

SINCE THE FATEFUL day of December 7, 1941 our ideas of what governmental activities are essential, important, or merely desirable have undergone a marked change. We no longer have the choice of automobiles or guns, washing machines or planes. We are called upon to take an active part in an all-out war effort requiring great sacrifices now and still greater ones in the future that we cannot foresee.

THE PROGRESSIVE FISH-CULTURIST cannot join the Marines nor are many of its editorial staff members subject to the draft but it can do its bit by saving paper and curtailing expenditure of funds. This issue requires over 1000 pounds of paper and over 50 sheets of zinc. While we do not concede that this almost strategic material is wasted in its present form or that economy and efficiency in the operations of the more than 500 fish hatcheries have not been promoted, we do believe in placing essentials first.

Accordingly, with this issue, the PROGRESSIVE FISH-CULTURIST will suspend publication in its present form for the duration. If circumstances permit, occasional numbers will be issued from time to time but in a much more condensed and modest form and containing only timely articles that will aid directly in the economical and efficient breeding of food and game fishes.

If these plans are disappointing, which of the two would you prefer in retaking Wake Island: An interesting well illustrated magazine or an extra hundred rounds of machine-gun amunition?

The Editor

TROUT MANAGEMENT IN NEW HAMPSHIRE

BIOLOGISTS' FINDINGS FORM BASIS OF STATE'S NEW PROGRAM

By Herbert E. Warfel
New Hampshire Fish and Game Department
Concord, N. H.

DURING THE PAST TWO YEARS the State of New Hampshire has been engaged in trying to put into operation a trout-management program based on the findings of a biological survey. The progress of the New Hampshire survey was watched by the whole fishery fraternity with considerable interest and the published results have been widely distributed so that a detailed discussion of that phase of the program need not be resumed. It is felt, however, that an accounting of the management procedure is needed at this time, both as a guide and as a report of progress in the utilization of biological data in the practical aspects of freshwater resources manipulation.

The New Hampshire survey was the outgrowth of sportsmen's demands that something be done to provide better fishing, particularly for trout. Although the New Hampshire Fish and Game Department had been stocking fish for upwards of 80 years, the fishing effort had begun to realize declining results, reaching such a low point that an imperative demand for positive action was made. A state-wide campaign by sportsmen resulted in the creation of a new administrative set-up consisting of a five-man, non-salaried commission which retains a director as chief executive officer.

Trout had been stocked in New Hampshire, as in other parts of the country, by private applications, conservation officer's requisition, and department plantings of excess fish. Three faults of this procedure were apparent to the new commission: the effort was casual and unplanned, it lacked unity, and it was based largely upon opinion. Fundamentally, lack of accurate information was the underlying difficulty.

Upon the practical completion of the survey a three-phase program was proposed as a foundation upon which to build management procedure. First, the sportsmen were promised fair distribution of hatchery stock to all suitable waters of the State, the number and kind to be based on the carrying capacity of each body of water. Second, a program of stream improvement was proposed and the streams were classified by the survey into three categories for this purpose. "A" streams are those which are, at the present time, capable of supporting trout; "B" streams are those that have trout-carrying possibilities but are not now stocked; and "C" streams are those that are considered worthless from the trout-management standpoint. Some of the "A" streams and most of the "B" streams are listed for improvement, although this phase of the program has not developed as yet owing to lack of funds and lagging interest in the face of the present national emergency. The third phase of the basic program is lake improvement, which has two parts. The first part concerns the reclamation of ponds and lakes for trout by removing competing and predator fish. Six areas have been treated with derris root for this purpose and suitable species stocked with marked success in most cases. The second part of the lake program,as yet in the experimental stage, grew out of an analysis of soil types in lake bottoms. It is an

attempt to determine the basic fertility of lakes and, if possible, to improve upon it. This paper is concerned with the first of the three phases of the basic program -- that of distributing and propagating trout.

PLANNED DISTRIBUTION SAVES TIME AND MONEY

When the New Hampshire stocking policy was outlined many factors were considered other than those derived from the biological data. Much of this additional information was secured from the Conservation Officers, most of whom had been patroling the same territory for several years. New Hampshire is fortunate in having a hard-working, conscientious warden staff, all intensely interested in the management of their territories. Therefore, in laying out management plans,

Many miles of meadow brooks like this are scheduled for improvement
(Photos by Manahan, Hillsboro, N. H.)

the Conservation Officer's territory was used as the management unit. The Conservation Officer is, in effect, the manager of his unit.

The next step in laying out the management plans was to assemble on "stocking plan sheets" all the available data, according to Conservation Officers' territorial units. Only pertinent data necessary for the purpose of distribution were entered on these sheets which were made large for ease of handling and to give room for any additional remarks that might be needed. A copy of this form was kept in the office and a copy was given to the Officer. The only additional data added that were not contained in the original was the approximate date of delivery. When this sheet was being filled out the Conservation Officer was called in, the details were gone over carefully, dates of delivery determined

and truck routes worked out. The stocking plan sheets served as a guide for the Officer's activities during the fish planting season.

To save time and expense in transportation, routes and trips are planned in advance. It is the aim of the fish distribution unit never to leave a hatchery without a full load of fish. This aim cannot always be realized, but planning has saved many miles and much time during the current season in spite of weather handicaps.

Planting time depends upon several factors. Among these are the size of the fish needed for a particular place, the availability of roads, the condition of the waters to be planted, and the fishing effort. Some ponds can be planted in the fall with reasonable assurance of returns from the stock the following season. Others cannot be so planted because of heavy predator populations, ice-fishing, or road conditions. Very few streams can be stocked in the fall with assurance of returns the following season, although there are some areas where this is necessary. Some planting is done around the summer holiday seasons and an especial effort is made to supply fresh stock in several areas around Memorial and Labor Days. These areas are scattered over the state sufficiently well that the first phase of the basic program is not violated.

When planting time approaches two forms are filled out. One is an order to the truck driver, made out in duplicate with one copy sent directly to the driver. The other form, a list of the plantings to be made, is sent to the hatchery that is to supply the fish. The superintendent of hatcheries receives a duplicate of this last item. After the planting has been made the truck order is returned to the office and the number and size actually planted (the size may vary slightly from the order) are entered upon the permanent records.

Supervision of the program is in the hands of a man promoted for this purpose and called Superintendent of Distribution. Dispatching trucks, planning this work and supervising the transfer of warm-water species is the full-time job of the Superintendent. He is assisted by one part-time stenographer in addition to the transportation staff.

Three sizes of fish are planted in New Hampshire waters. Fry are sac-frv (or occasionally advanced fry) and generally are designated for those places inaccessable to trucks. These fish are often carried in tanks on the backs of men who, using snowshoes, put them into headwater streams. Fingerlings, ranging from one to five inches in length, are planted in various situations and most often are used to supplement the legal-sized plantings that are made in streams. Legal fish are planted with no other thought in mind than that they will supply most of the fish during the season. Legal fish, six inches or over, serve to take the shock of the heavier concentrations of the fishing load.

The biological survey policy designates the number of legal-sized fish to be supplied to many waters. It is hoped that fingerlings, when planted in addition to the legal fish, will utilize the streams for growth and in time will furnish what the angler terms "native" fishing. Some streams get plantings of all three classifications. Most river systems receive plantings of all sizes in one tributary or another. Fingerling stocking, when used alone, has generally proved unsatisfactory in supplying a sustained yield. It remains to be seen whether it will assist in maintaining a permanent population in streams that are also stocked with fish ready to be caught.

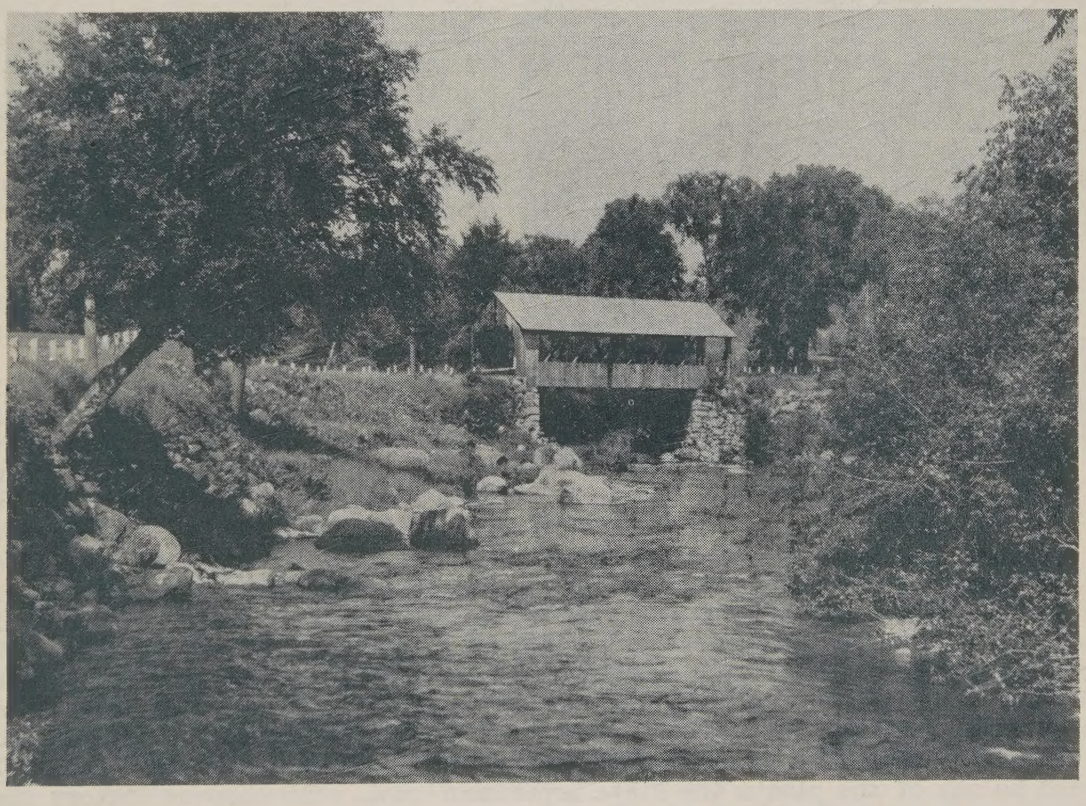
THE PLACE OF THE HATCHERY

The role of the hatchery in present-day fish management is being widely debated. Certainly in some types of fish management the hatchery has been

demonstrated to be valueless. In trout management in the northeast, however, it is a definite necessity-the backbone of the whole trout-management structure. It is quite probable that if the amount of money spent in rearing fish in hatcheries could be put back on the land in the form of water improvements and reforestation, trout populations could be restored, in time, to a semblance of their former abundance. But money spent in this fashion would not solve the immediate problem of providing fishing for the thousands that now pursue the sport. Furthermore, even if populations could be restored to a point near their former size, the concentration of anglers on the waters at the present time is so heavy that hatcheries would still be needed to augment the supply of native fish.

A management policy based upon a biological survey is advantageous from the hatchery standpoint in that for the first time in the history of trout exploitation the place of the hatchery is definitely assured. Furthermore, a concrete plan of operation can be laid out.

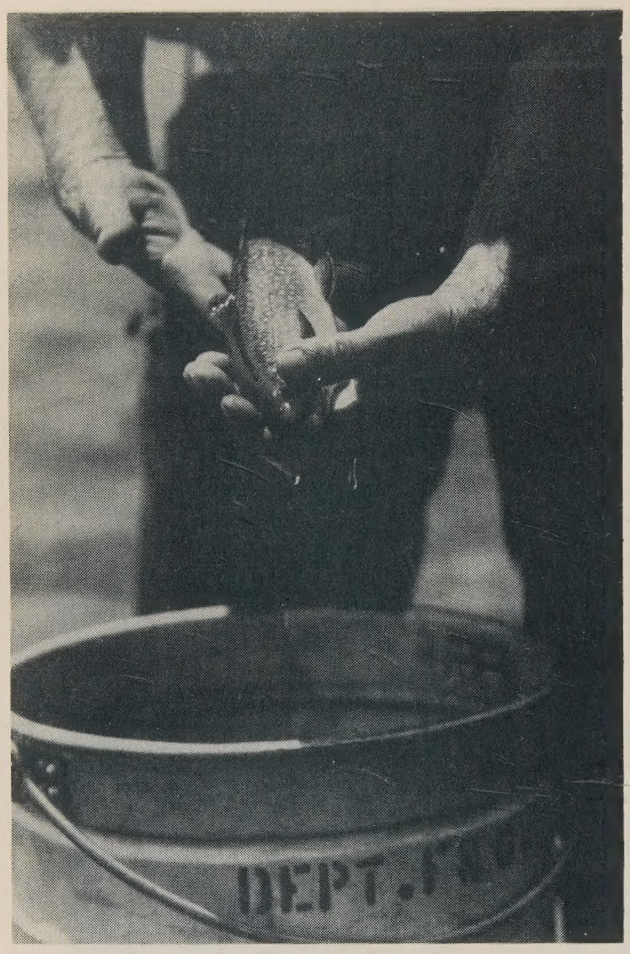
The New Hampshire plan of management calls for definite production in terms



Mascoma River near Lebanon, a typical tributary of the Connecticut River

of species, numbers, and sizes for each of the 7 hatcheries and rearing stations operated by the State Department of Fish and Game. It is then a relatively easy matter to plan the outlay of funds and the operating program for each year. Further advantage is gained in that, having a plan laid out in definite fashion, when unavoidable deviations from the program occur they are readily spotted and corrections can be made before the whole management program is upset.

The biological survey policy calls for rearing and stocking 3 species of trout - brook, rainbow and brown - for the major part of the program. Brook trout, native to the north-east, far outnumber the other two and the greatest part of the State rearing plant is devoted to that fish. The production schedule was purposely kept to a minimum the first year. There were two reasons for this: an opportunity to gauge the productive capacity of the stations was sought, and it



A hatchery-reared brook trout.

was desired to expand according to a planned manner rather than in the "hit or miss" fashion.

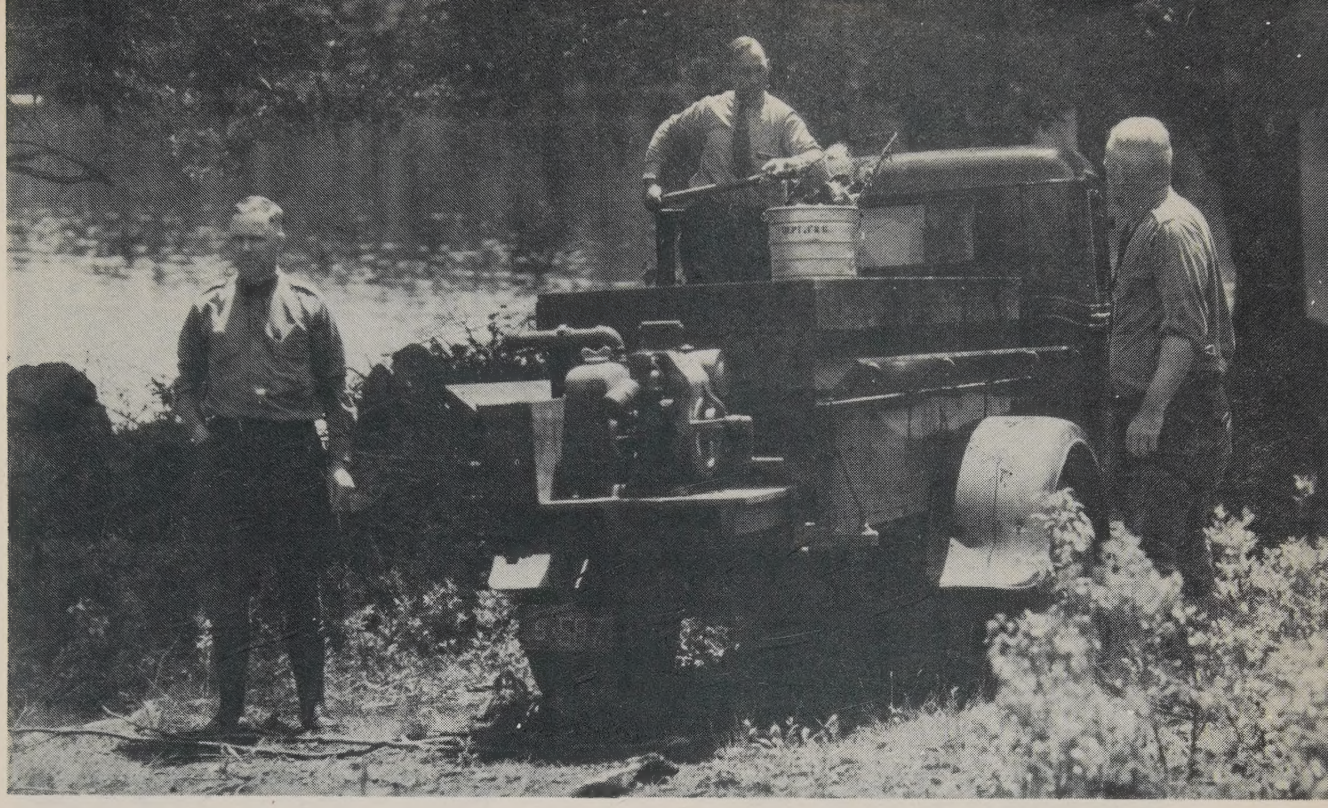
Drawn into this picture are two Federal hatcheries located in the state. The Fish and Wildlife Service, working toward the same end as the State Department of Fish and Game, has made these stations available and the State cooperates by furnishing food and part of the necessary labor. The state plants all the fish reared in these stations according to the distribution program outlined above. A few fish are released to private individuals for planting but under a new agreement few will be disposed of in this manner in the future. There are still a few individuals who file applications for fish with the Fish and Wildlife Service, but the Service cooperates by sending these applications to the State for review and recommendation before they are filled. These consignments are fitted into the regular program and deductions made accordingly from the State plans.

The considerations governing production at each hatchery or rearing station are: the location of the plant, the facilities of the plant, and the growing conditions at each place, including the disease history.

In a general way location determines the species of trout to be handled in each hatchery. Brown trout, for example, are mostly planted in the southeastern part of the State, therefore the Nashua Federal Hatchery is being used for this trout. In the far northern part of the State a hatchery is located at Colebrook. This is a hatching station with very few rearing facilities and is used to hatch about half a million brook-trout fry that are needed in that section, in addition to some lake trout for nearby lakes. Rainbow trout are needed in many parts of the state and these are reared at the New Hampton which is about as centrally located as any of the plants the State Department owns. The disease history also dictates production of this species, at the present, in a large section of this plant.

The stage of development of the physical plant (building, etc.) and the abundance of the water supply generally govern the number of fish produced. Suitable hatchery water is difficult to find in New Hampshire and some of the plants have water that is far from ideal. Some plants at present are overdeveloped for the production of fish under the best conditions and some can be expanded. Correcting these features awaits necessary funds.

The New Hampshire Fish and Game Department, in common with other fish and game departments, has had considerable experience in attempting to construct rearing pools and operate them without the necessary basic facilities and now proceeds with caution in the matter of expanding its present rearing-pool set-up.



Fish distribution trucks are equipped with pumps to circulate water.

Measures to correct unsound basic conditions are far more costly than they are worth.

Growing conditions, of course, cannot be considered apart from the nature of the water supply. Lack of attention to water temperatures, a fundamental factor in trout growth, is a common fault the country over. Widely fluctuating temperatures as well as those that exhibit but little variation, exist all over the State. There is not a plant in New Hampshire in which these conditions cannot be improved. The chief difficulty has been to secure accurate records and too often temperatures were taken without any particular reference to the location of the fish in the plant.

The New Hampshire Department recognizes that growing conditions need to be carefully studied and continuously observed and recorded to obtain maximum results. An attempt is being made at the present time to institute a system of growth records that will enable a monthly check to be kept of progress in all the plants. Preliminary results have been encouraging. Several difficulties in production have been uncovered before they became serious and these have been corrected; still others have revealed basic disadvantages that will require the outlay of funds before they can be properly adjusted.

The aims of the production unit of the New Hampshire Fish and Game Department can be summed up as follows: to rear the number of each species to the desired size as rapidly and as inexpensively as possible. Specifically this means: have as many six-inch trout on hand at the beginning of each fishing season as the biological survey policy calls for, and do it with expenditures sufficiently low that maintaining State-operated hatcheries is eminently worthwhile.To accomplish these aims experiments on diets and selective breeding are under way at the present time and studies of the individual plants aimed at improving general growing conditions are constantly being made.

PROGRAM BASED ON COMMON SENSE PRINCIPLES

The procedures outlined in this brief discussion are not at all revolutionary and are relatively simple. In fact they are so simple that when a new

New Hampton hatchery - the largest operated by the state.

A typical White Mountain stream

director came into the department in July 1940 his comment on the program was: "This is all so common sense I cannot understand why it hasn't been done before". The only answer that can be given is that the fundamental information was lacking. It is the first time that any definite figures for planning have ever existed. No blame is to be attached to anyone for the lack of orderly planting and rearing of fish. The very nature of the problem, in its specific aspects, and the fact that it has been public activity as opposed to private work, accounts in large measure for the slowness of efficient development in this field.

It is also to be remembered that this program is really an experiment on a large scale. It is an attempt to prove that, knowing certain fundamental facts concerning the water of an area, it is possible to provide the public with trout fishing by regular, consistent planting of hatchery-reared fish. That the program is not perfect is a fact only too well known to the officials of the New Hampshire Fish and Game Department. Constant assaults against parts of the program are continuously made by well-meaning sportsmen, mostly based upon the hearsay evidence of the "old-timers". Eternal vigilance is required to keep the program coordinated and functioning. On the whole, however, cooperation from all agencies has been much better than one would expect. The very fact that when questions are raised there is an answer ready, or at least records enough to make an understanding of the problem possible, is the greatest help in keeping the program going.

To gain the fullest cooperation of the sportsmen every opportunity has been seized to present the ideas behind the program to the public. Lectures and newspaper publicity, together with rather wide distribution of the biological survey reports, have been utilized to educate the people and show them what is back of the change in policy. It is apparent that too little attention has been given to the biological education of sportsmen in the past. The intelligence of the American people is vastly underrated and it is perfectly possible to show them the reasonableness of a sound, efficient program of this sort. More good can be achieved from frank, honest discussions of the weaknesses and shortcomings of a program than from trying to hide these things. Sportsmen's club meetings make ideal opportunities to get the right kind of information to the people most interested in fish management.

Recognizing that this program is really a big experiment, an effort is being made to check the results. A stream creel census, in terms of trout per hour of fishing effort, has been designed and will be continued for the next three years. It is planned also to check the various species, sizes, and numbers on this same basis during this time.

In conclusion it can be said that, in addition to getting the right trout in waters possessing characteristics nearer the optimum for each species than was possible before, definite and detailed plans can be formulated that render the management of trout much more efficient.

The idea of planned activity cannot be too strongly emphasized. The advantages are many but chiefly they allow for checks on deviations and more immediate opportunities for the correction of mistakes.

A DRIP INCUBATOR AND HEATER COMBINATION

DEVICE SOLVES PROBLEM OF LIMITED WATER SUPPLY PLUS LOW TEMPERATURES

By James R. Simon and Floyd Roberts
Wyoming Game and Fish Commission
Cheyenne, Wyoming

MANY SUPERINTENDENTS OF TROUT HATCHERIES are confronted with two major problems: (1) a limited water supply and (2) low water temperatures. A small water supply often limits quite definitely the work a hatchery can undertake, while water of low temperature does not allow normal development of eggs or maximum growth of fry in a given length of time. The Western Drip Incubator used with or without the heater has helped solve the water problems in two Wyoming State hatcheries where better use of available water or water of higher temperature was needed.

Experiments in heating water have been conducted, principally at the Federal hatchery at Spearfish, South Dakota, by T. S. Kibbe. These experiments have proved that raising temperatures to optimum have produced larger, healthier trout in a shorter time. The Spearfish Hatchery experiments were confined to the use of heated water in standard hatchery troughs. Work was done with heated water during the incubation period of the trout eggs but not in a drip incubator, although use of an incubator-heater arrangement was suggested at the time.

To overcome, in part, the problem of water shortage, the Wyoming Game and Fish Department decided to adopt the Western Drip Incubator then in use at the Bureau of Fisheries' Lake Station, Yellowstone National Park. This trout-egg incubator was developed by Fred J. Foster, now Assistant Regional Director, U.S. Fish and Wildlife Service, Region 1, and his associates in the work, both Federal and State. Members of the Wyoming Game and Fish Department observed the use of the drip incubator at Lake Station during the summer of 1938.

Certain changes in the original plan were made by the State Department during the construction of a unit for the State Fish Hatchery at Dubois during the fall of 1939. In view of the small amount of water needed to incubate eggs it was later decided to install a heating system; and this heating system was used in an incubator installed in the State Fish Hatchery at Story, 1941. Heaters were not used in the original incubator by the U. S. Fish and Wildlife Service.

DESCRIPTION OF INCUBATOR [1/]

A single unit of the Western Drip Incubator as used by the Fish and Wildlife Service is described as follows:

> A cabinet of galvanized sheet iron 43⅛ inches high, 51⅛ inches long and 29½ inches deep. The cabinet is made of 26 gauge gal-

1/ The incubator is described here with the permission of Fred J. Foster.

vanized iron in the ends, through the central dividing partition, and between the sections. Three-eighths inch stove bolts are used throughout. Legs are made of 3/4 by 3/4 by 1/8 inch angle iron for the corners,and 1 by 1/8 inch strap iron for the front center legs on both sides. 3/4 by 1/8 inch strap iron is used for all braces.

This cabinet or single unit has six sections each 43½ inches high, 16 inches long and 14 inches deep. Each section is divided into seven compartments, each of which holds a stack of five trays. Trays measure 13½ by 16 by 3/4 inches and their bottoms are covered with heavy mining cloth to eliminate sag.

Each section has a single head pan 14 by 16 by 1½ inches drilled with 1/16-inch holes one inch apart, of 16-gauge galvanized iron. Each compartment or stack of trays has a spreader pan. Spreader pans are 14 by 16 by ½ inches and are drilled with 1/16-inch holes one inch apart, 16-gauge galvanized iron.

Each stack of trays slips in and out of its compartment on 3/4 inch angle-iron slides, spaced 5 3/8 inches apart. Just enough space is allowed between the bottom of one stack and the top of the other to get the fingers under easily.

The head trough is a 5 by 7-inch wooden trough and is set on the unit and fitted with ½ inch valves, one for each section. The floor pan is the size of the unit and 3 inches deep.

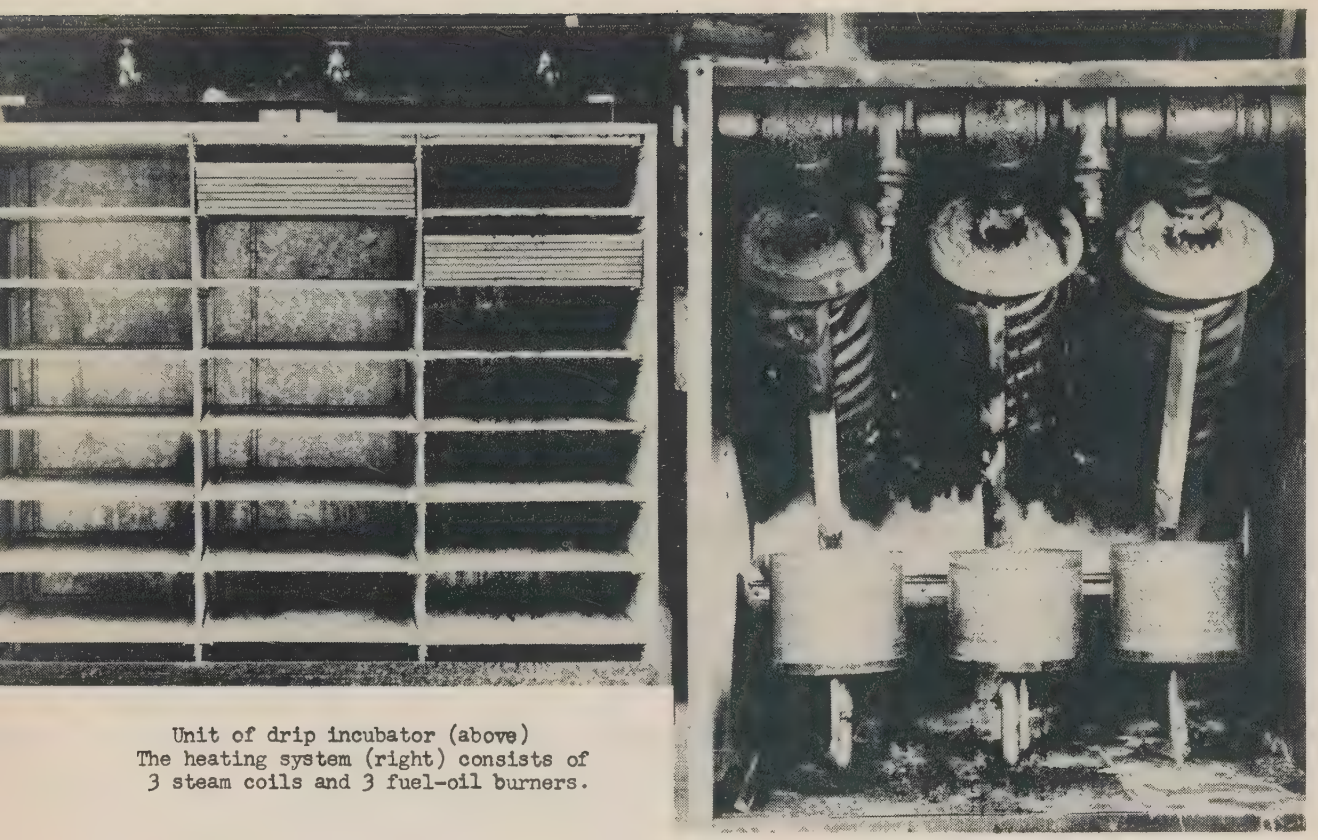
Mr. Foster points out that at some stations it is advisable to cover the eggs with one layer of cheesecloth to aid in uniform spreading of the drip and that where sediment is present in the water, cheesecloth or some other filter material can be of benefit in the spreader pan.

It is important that the incubator be level so that trays are not tilted as any unevenness tends to drain water to one side.

Any number of units as described above can be joined together and used as one large incubator.

Changes in design for use by the Wyoming Game and Fish Department are as follows:

1. Spreader pans are constructed of 20-gauge metal rather than 16-gauge.
2. Metal head troughs rather than wooden ones are used. The metal trough is lighter and easier to clean.
3. Seven trays per stack in each compartment are used rather than five. Each tray is 1/2 inch deep rather than 3/4 inch.
4. Tray slides are made of 20-gauge galvanized iron rather than angle iron. The slides are formed as 3/4 by 3/4 inch angle iron would be but with 1/4 inch of the supporting surface turned down at a 25-degree angle. This leads drip and splash that misses one pan into the pan below (See photograph - note how edges of slides overlap pans).
5. The head trough is raised 2½ inches above the head pan. This allows pans to be removed more easily for cleaning.



Unit of drip incubator (above)
The heating system (right) consists of
3 steam coils and 3 fuel-oil burners.

HEATING THE WATER

An additional value to be had in the use of the drip incubator is the fact that when advisable water can be heated at small cost and in small quantities for a relatively large number of eggs. That raising temperature during incubation is of value where only water of very low temperature is available is shown by Kibbe.[2/]

The heating system as designed and installed by Floyd Roberts is as follows (see photograph):

For each unit three No. 80 Hotsteam triple coils and three 8-inch fuel-oil burners are used. The flow of oil is regulated by safety float valves.

Coils are set at an angle just steep enough to cause moisture to drip off the lower side into small drip troughs. Unless set correctly the drip may extinguish burners. If tipped too steeply, steam may cause pounding.

At the Story Hatchery 42-degree water heated to 60°F. This water was then mixed with 42-degree water in the head trough of the incubator to maintain a constant flow of 52-degree water which was used for incubating the eggs. (52-degree water was considered optimum). The burners were set so that after heating and mixing the water could be no warmer than 52°F.

2/ Kibbe, T. S.
1938. An experiment on heating water for fish cultural purposes. Prog. Fish. Culturist, No. 31, May 1938, pp. 19-22

1939. Further notes on heating water for the culture of trout. Prog. Fish. Culturist, No. 43, March-April, 1939, pp. 19-23.

College Park Maryland

Table 1. Comparison Between
Single Incubator Unit and Two Standard Hatchery Troughs[1/]

Egg Capacity	Water Needed	Floor Space Required	Temperature (Story)	Eyeing Time Rainbow (Story)
2 Standard Hatchery Troughs 500,000	18 g.p.m.	36.4 sq.ft.	42°F Without heater	38 days
1 Unit Incubator 2,700,000	4½ g.p.m.	11.5 sq.ft.	52°F With heater	14 days

[1/] Hatchery troughs 7" x 14" x 14'

ADVANTAGES OF INCUBATOR-HEATER SUMMARIZED

1. Floor space is saved.
2. Water is saved, thus increasing efficiency of hatcheries with small water supply.
3. Water gains oxygen when passing through the drip system.
4. Incubator eggs are more conviently checked and handled.
5. Units are portable and can be dried and sterilized easily.
6. There is a slight increase in percentage of hatch with incubator eggs. Less fungus was encountered.
7. Water for the incubator can be heated more cheaply than for troughs.
8. Fine sediment drained off through the drip pans rather than adhering to eggs.

SALVAGE OF GRAND COULEE FISH PROGRESSES

In connection with the Grand Coulee fish salvage program of the Fish and Wildlife Service, United States Department of the Interior, the work of transporting salmon and steelhead trout from Rock Island Dam to the holding ponds at the Federal hatchery at Leavenworth is still being continued.

From April 1, the beginning of hauling operations for the season, to the week ended December 13,1941,the number and species of salmon and steelhead trout trapped at Rock Island and hauled and liberated to localities below Grand Coulee Dam were as follows: 2,567 chinook salmon, 949 blueback salmon, 29 silver salmon, and 3,561 steelhead trout.

The number and species of salmon and trout hauled to each locality were as follows: Nason Creek: 1,252 chinook salmon and 899 steelhead trout; Leavenworth hatchery: 777 chinook salmon,851 blueback salmon,29 silver salmon, and 2,587 steelhead trout; Wenatchee River: 448 chinook salmon, 98 blueback salmon, and 2 steelhead trout.

Raceways at the Woodruff Hatchery. (Photos by Wisconsin Conservation Department)

FISHERY RESEARCH IN WISCONSIN

By Edward Schneberger
Wisconsin Conservation Department
Madison, Wisconsin

THE STATE OF WISCONSIN CONTAINS within its borders approximately 7,500 lakes and 15,000 miles of streams. In addition it has 350 miles of Lake Michigan and Green Bay shore on the east, 150 miles of Lake Superior on the north and 250 miles of the Mississippi River on the west. Consequently, sport and commercial fishing constitute very important industries in Wisconsin. The tourist trade is estimated to bring upwards of 200 million dollars into the state annually, and is rated as an industry next to agriculture in importance. With these facts in mind it is obvious that a fishery management problem of unusual magnitude exists.

In an attempt to solve the problem of maintaining good fishing, 33 fish hatcheries and their accompanying rearing ponds were established long ago and have been operated to full capacity for many years. In recognition of the dire need for more technical and scientific information, the Wisconsin Conservation Commission created the Biology Division late in the summer of 1937 for the purpose of conducting research pertinent to the state's fishery program. The writer was appointed Chief Biologist and given the responsibility of building up the division and supervising the activities.

The first problem of the newly created division was that of formulating a program and a general policy. It was the writer's good fortune that the American Fish Policy, as published in the 1938 volume of the Transactions of the American Fisheries Society, was taking shape at the same time. Considerable reference was made

Culturing Bacterium salmonicida in the laboratory (left).

The author making a field analysis of water in one of the small winter freeze-out lakes (right).

to that policy and many points were adopted.

The second problem was the acquiring of suitably trained personnel. At present the Biology Division is a relatively small organization comprising only six persons; namely, the Chief Biologist in charge, three Junior Biologists, a Junior Bacteriologist, and a Supervisor of Lake and Stream Improvement. The Chief Biologist is located in the department office in the State Office Building. The three Junior Biologists, located one at each of the three fishery area headquarters and serving as area biologists, are Dr. L. A. Woodbury at Madison, D. John O'Donnell at Spooner, and L. O. Williamson at Woodruff. Dr. L. L. Gee, Junior Bacteriologist, is located at the southern fishery area headquarters and Otis Bersing, the Supervisor of Lake and Stream Improvement, is located at a strategic point in the Forest Protection Headquarters at Tomahawk. Plans are now under way to add three more biologists as assistants to the area biologists.

The laboratory facilities of this division consist of a main laboratory and two field laboratories. The main laboratory is located at the Nevin State Fish Hatchery at Madison. Equipment and space are available to conduct research on

various types of problems pertaining to fishery management. The field laboratories located at Spooner and Woodruff contain, in addition to office facilities, space and water for tank aquarium experiments and equipment for chemical analysis.

FISH DISEASES ARE MAJOR CONCERN

The prevention and control of fish diseases continue to demand most of the time and effort of the biologists. The old adage that "an ounce of prevention is worth a pound of cure" is fully applicable to fish diseases. Improper diets, overcrowding, high temperatures, et cetera, are factors that contribute materially to the development of diseases against which we must continually be on guard. In spite of all precautionary measures, however, outbreaks will occur, and so it is necessary to know how to control or treat diseases. Experimentation with new drugs and other therapeutic measures is constantly in progress.

Research is conducted especially on Furunculosis or red spot, the most dreaded of all fish diseases. It is a blood poisoning or septicemia caused by bacteria and is extremely vicious. Once Furunculosis gains a foothold it is likely to be fatal to as many as 95 to 100 percent of the fish. No cure is known. The preventive measures that can be applied are faulty, but even so, their application must not be overlooked. Prevention of Furunculosis demands the most scrupulous attention to sanitation. Extreme care is required to clean up a hatchery that has once been contaminated. All tools, equipment, raceways, floors, tanks, in short everything around the hatchery that might be a source of contamination must be sterilized. Once the sterilization has been completed only eggs may be brought into the place and these eggs also must be sterilized by dipping for 30 minutes into a 1/2000 solution of acriflavine, buffered to a pH of 7.5 to 8.0. The fry hatched from these eggs must be raised under conditions that are as sanitary as possible.

That disinfection and sanitation are extremely valuable was proved definitely at the Westfield hatchery in 1939. All existing stocks of fish were removed and all the raceways, troughs, tanks, and every piece of equipment - no matter how small or large - were scrubbed clean and then disinfected by a 200 p.p.m. chlorine solution. No fish were brought to the station, and only eggs which had been carefully disinfected were brought in. The strictest possible sanitary and quarantine measures were enforced. The net result was that the Westfield station has remained free from disease. At the Osceola and Thunder River hatcheries, which had always been scenes of Furunculosis epidemics of great proportions, our experience was similar. Both of these stations received a thorough cleansing and disinfection. The Osceola station remained free of disease but a slight epidemic broke out at Thunder River during the past summer. Fortunately it was kept under control and limited to only four tanks.

Experiments designed to create artificial immunity, now in progress, have shown some extremely promising results. A serum was made by injecting the disease-producing bacteria into rabbits and goats and then bleeding these animals for the serum containing the antigen. This material was then injected into fish suffering from Furunculosis. The results obtained from the work were very encouraging but this phase of the problem will demand considerably more research before definite results are available.

FUNGUS CONTROL SAVES TIME AND MONEY

Advances made this year by the Biology Division in the control of fungus on trout eggs being incubated in the various hatcheries have resulted in large savings

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of time and money. Dead or dying eggs are attacked by the water fungus Saprolegnia. If the growth of the fungus is not arrested, it spreads into a dense mat which in time entangles and kills healthy, live eggs. The general procedure of the fish culturist was to pick out the dead eggs once or twice a week, taking special care to remove those with fungus. By a simple administration of about an ounce of saturated copper-sulphate solution to the water entering a battery of eggs, the fungus growth is practically eliminated and the eggs need be picked over only once in about two weeks. In one experimental unit the picking was suspended for 30 days. At the termination of the experiment no fungus was growing and the hatch was of good quality. This procedure saves the fish-culturist a great deal of manual labor and also gives him a good hatch of fry.

NUTRITIONAL STUDIES ALSO ESSENTIAL

The feeding of trout in the various hatcheries is a problem that demands and is receiving considerable attention. The aim is, of course, to find a diet that is inexpensive but will still provide those elements that are necessary to growth, health and vigor of the fish. Briefly, the experiments have been designed to utilize the canned carp produced by the department. Experiments have shown that it is necessary to add some fresh meat and vitamin B_1 at regular intervals to this diet in order to maintain vigor and growth in the trout. Vitamin B_1 deficiency was clearly demonstrated in an epidemic among the rainbow trout at the Thunder River hatchery in the fall of 1939. Injection of crystalline B_1 cured the fish. Later the condition was duplicated experimentally and the fish cured by the injection of crystalline B_1 and by the addition of dried brewer's yeast to the diet.

FIELD STUDIES ON ECOLOGICAL RELATIONSHIPS

A knowledge of the food habits of all species of fish in their natural environment is of great value in fish management. Years ago the suckers and redhorse were accused of feeding upon the eggs of such game fish as pike-perch or walleyed pike and muskellunge. Therefore, it was believed that the population of game fish would increase if the suckers and redhorse were removed from the water. Stomach analyses of fish caught during the spawning periods of walleyed pike or pike-perch and muskellunge revealed that only occasionally do suckers and redhorse consume the eggs of these species. Since suckers and redhorse serve as forage for the larger game fish they are now considered valuable to the game fish population rather than destructive. The yellow perch is found to feed quite extensively on the eggs of game fish, and in many of the northern lakes the population of perch must be reduced.

Considerable assistance and aid is given and received from other state departments such as the State Board of Health, Natural History Survey, and Economic Land Inventory. The Chief Biologist was recently named a member of the State Committee on Water Pollution. Consequently, a great deal of attention was directed toward pollution problems with emphasis on a closer cooperation with the Bureau of Sanitary Engineering of the State Board of Health. Six pollution situations were corrected readily by the offenders when they realized that prosecutions were likely to follow the investigations of biologists and sanitary engineers. Legal action was taken in two other cases both of which resulted in convictions.

A NEW METHOD OF COMBATING FUNGUS INFECTIONS

By D. John O'Donnell
Wisconsin Conservation Department

IN LARGE-SCALE FISH propagation, rescue and transfer operations as conducted by the State of Wisconsin the proper care and handling of all fish planted is a matter of the utmost concern. However, it is almost impossible to avoid slight injuries to the fish during the processes of trapping, sorting by hand or with dipnets, weighing and counting, transporting and planting. Even though care is used, physical injury often occurs. When fish were placed in ponds in which an opportunity was afforded for observation, quite often an infection of fungus would develop within a few days. The fungus involved was one of the water molds or Saprolegniaceae, and the most common species encountered in fish is Saprolegnia parasitica Coker. A comprehensive morphological study of this species has been made by Kanouse[1/], but Clinton[2/] was probably the first person to make general observations on Saprolegnia and its effect upon fish.

Many methods have been tried in an attempt to cure such fungus infections. The recommended treatment of dipping in a 3 percent solution of salt (sodium chloride) until the fish show signs of distress, then removing to fresh water and repeating on successive days, proved ineffective. Also, the methods of dipping for one minute in a 1 to 2,000 solution of copper sulphate or for 30 minutes in a 1 to 100,000 solution of potassium permanganate were equally ineffective. It was apparent that we were in need of an efficient fungicide which could be used safely by personnel without special training and which would cause a minimum mortality during treatment. It was further desired that the material used in treatment should have some antiseptic properties, to facilitate the healing of the broken epithelium of the fish, after the fungus had been killed and sloughed off.

A review of the literature revealed a number of recommended treatments, all of which have been used as common practice. The German workers, Hofer[3/] and Plehn[4/], had discarded the use of a salt solution and recommended a dip in a 1 to 100,000 solution of potassium permanganate for 30 minutes or longer. Davis[5/] recommended either a dip in a 3 percent solution of salt until the fish show signs of distress or a dip for one minute in a 1 to 2,000 solution of copper sulphate. In 1936, Foster and Woodbury[6/] reported a new method which proved successful on a special lot of trout. However, this treatment was not tried on a large number of species of fish and apparently it has failed to supercede the older methods of salt and

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1/ Kanouse, Bessie B. 1932.
A physiological and morphological study of Saprolegnia parasitica. Mycologia, 24: 431-452.

2/ Clinton, G. P. 1894.
Observations and experiments on Saprolegnia infesting fish. Bull. U.S. Fish. Com., 13: 163-172.

3/ Hofer, B. 1904.
Handbuch der Fischkrankheiten. Stuttgart, Schweizerbart.

4/ Plehn, M. 1924.
Praktikum der Fischkrankheiten. Stuttgart, Schweizerbart.

5/ Davis, H. S. 1937.
Care and diseases of trout. U.S. Bur. Fish., Investigational Report No. 35.

6/ Foster F. J., and Woodbury, L. A. 1936.
The use of malachite green as a fish fungicide and antiseptic. The Progressive Fish Culturist, 18: 7-9.

copper sulphate. The fish on which they experimented were seriously affected with fungus and consisted of a special lot of exhibition trout (Mackinaw trout, black spotted trout, Eastern brook trout and rainbow trout), on display at the Yellowstone Park Fish Hatchery. Upon developing an acute infection of fungus, several treatments were tried. Dipping on alternate days in a saturated salt solution and a 1 to 2,000 copper sulphate solution was ineffective. Then a 1 to 1,000 solution of copper sulphate was used, which proved toxic and killed several fish. A 1 to 10,000 solution of potassium permanganate and a 1 to 8,000 solution of potassium dichromate were also ineffective. In the hope that malachite green, which is known for its bacteriacidal properties, might act as a fungicide, experiments were made to determine the toxicity to trout. It was found that a 1 to 10,000 solution was non-toxic to healthy, adult trout when dipped for 3 to 5 minutes. The fungused trout were therefore dipped in a 1 to 10,000 solution for 3 minutes, on each of 4 successive days. The fungus disappeared during the treatment and did not reappear during the balance of the season.

Malachite green is also known as analin green, benzaldehyde green, fast green, diamond B green,solid or benzal green,all of which are the chloride of tetramethyl-di-p-aminotriphenylcarbinol. Due to the possibility that zinc might be toxic to fish and therefore cloud the results only the zinc-free dye was used.

Because of the success in the use of malachite green in the above trials, it was decided to conduct extensive experiments on its use, with a number of species of fish, both warm-water and cold-water types.

Largemouth Black Bass. During the course of experiments wherein largemouth black bass were injected with pituitary extract, an acute fungus infection developed. The adult bass were being held in one of the Spooner rearing ponds. These consist of 22 ponds in all and are used for fish production, exhibits and as holding ponds for experimental fish, all of which involves considerable traffic and handling. After repeated dippings in various concentrations of dye and varying time intervals it was determined that a 1 to 15,000 solution of malachite green, with dips of 30 seconds, had the least harmful effect on the fish. An increase in time and strength of solution allowed the dye to penetrate to the inside of the gill filaments, causing the death of the fish. The malachite green was efficient in weaker solutions of 1 to 20,000, 1 to 25,000, and 1 to 30,000, but it was necessary to give two or three dips on successive days if the infection was light and additional dips if the infection was heavy. All largemouth black bass brood stock were dipped in a 1 to 15,000 solution for 30 seconds and returned to the pond. The fungused areas remained dyed green for several hours after treatment. In twenty-four hours, the fungus had sloughed off and the fish were healing. As a general preventative, all fish were dipped after each period of handling and immediately before being returned to the holding pond. No further fungus infection appeared and the treatments caused no loss whatsoever.

Other Warm-Water Fish. At various times during the summer and under varying water temperatures, toxicity experiments were run on smallmouth black bass, bluegill, common sunfish, perch, black crappie, walleyed pike, muskellunge, northern pike, and two minnows, the bluntnosed and the fathead. Smallmouth black bass were very hardy and could tolerate repeated dippings up to and including two minutes. The gill filaments seemed to resist penetration much better than those of the largemouth black bass. The bluegill, common sunfish, perch and black crappie exhibited no mortality with dips of 30 seconds duration. The minnows, walleyed pike, muskellunge and northern pike were freed of fungus with dips of 10 seconds. No attempt was made to determine the lethal time on the last named species. Brook trout, brown trout and rainbow trout were cured with dips for 30 seconds when the fungus infection was light. If the infection was heavy, additional dips of 30

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seconds' duration on successive days were required to free the trout completely of fungus.

Rescue and Transfer Operations. Following the rescue and transfer operations of the fishery division in the past, there were a number of complaints of sick fish, within a few days after a planting. Upon investigation these fish would be found to be swimming along shore, in a very weakened condition, and also, to be badly affected with fungus.

During the summer operations of 1941, the biology division at Spooner prepared a number of packets of malachite green (zinc free) to be used by the planting crews. Each packet contained enough dye (2 grams) to make a 1 to 15,000 solution when added to 8 gallons of water. A new solution was used for each load of fish and all fish were dipped for 10 to 30 seconds immediately before being planted in a lake. All fish handled on rescue and transfer operations were given this treatment. As a result, no complaints were reported of sick or dying fish. In addition, the show fish and breeders used in state ponds located in the seventeen counties in the northwestern part of the state were given the malachite green treatment and no cases of fungus developed throughout the season. Exhibit fish taken to fairs and sport shows, where ordinarily a large number of fish are lost, were given the treatment when placed on display and again when returned to holding ponds. In 1941, no loss occurred.

Results of these experiments indicate that dips in a 1 to 15,000 solution of malachite green for 10 to 30 seconds gave the most satisfactory results. The mortality was zero and in practically every case, one treatment or dipping was sufficient to completely rid the fish of fungus and promote healing. Occasionally it was necessary to give two or three dips, at intervals of two days, especially to trout which had been purposely allowed to develop severe infections for experimentation.

During the season, 454,000 adult fish, comprising 13 species were treated with malachite green, without loss. In addition, 248,435 fingerlings of 8 species from state production ponds, 261,410 fingerlings of 5 species from Federal Hatcheries, and 112,812 fingerlings of 9 species from state cooperative rearing ponds were treated with malachite green when planted. The total number of fish of all species, both fingerlings and adults, receiving the treatment during 1941, was approximately 1,076,600.

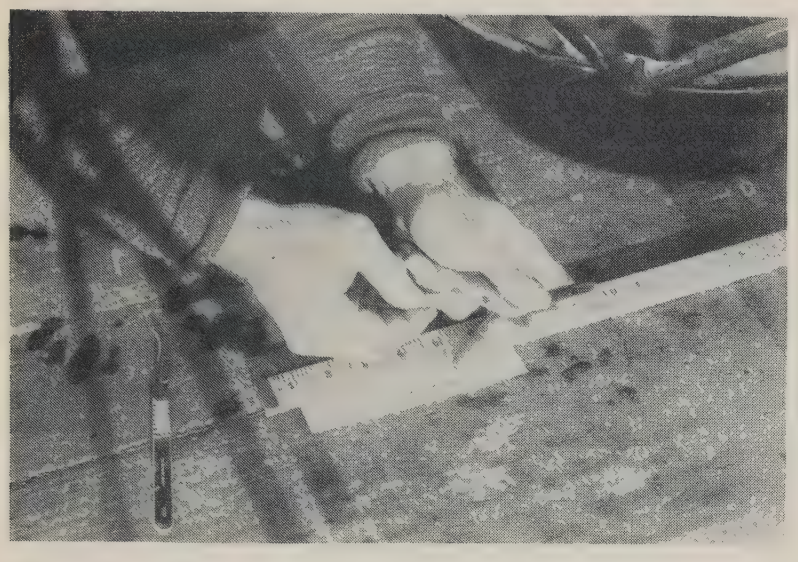
SUMMARY

1. A dip treatment of 10 to 30 seconds duration, in a 1 to 15,000 solution of malachite green, was non-toxic to the eighteen species of fish upon which it was used.

2. Malachite green was efficient as a fungicide and its antiseptic qualities hastened the healing of sores, which were exposed after the fungus had sloughed off.

3. The following eighteen species of fish were successfully treated with malachite green; Huro salmoides, largemouth black bass; Micropterus dolomieu dolomieu, smallmouth black bass; Lepomis macrochirus macrochirus, bluegill; Lepomis gibbosus, common sunfish or pumpkinseed; Ambloplites rupestris rupestris, rock bass; Pomoxis nigro-maculatus, black crappie; Perca flavescens, perch; Catostomus commersonnii commersonnii, common sucker; Ameiurus melas melas, black bullhead; Stizostedion vitreum vitreum, walleyed pike; Esox lucius, northern pike, Esox masquinongy masquinongy, muskellunge; Salvelinus fontinalis fontinalis, brook trout, Salmo trutta fario, brown trout; Salmo gairdnerii irideus, rainbow trout; Pimephales promelas promelas, fathead minnow; and Hyborhynchus notatus, bluntnose minnow.

4. A total of 1,076,600 fish of all species were treated with malachite green during the summer of 1941. Of these, 454,000 were adult fish and 622,600 were fingerlings which varied from 3 to 9 inches in length.



BELLY TAGS FOR BASS

PRELIMINARY RETURNS FROM THE TAGGING OF FINGERLING SMALLMOUTH BLACK BASS

By Eugene W. Surber
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Kearneysville, W. Va.

ON SEPTEMBER 25, 1939, 1,734 smallmouth bass fingerlings ranging from about 4.3 to 6.8 inches in length were tagged by the insertion of red celluloid belly tags into their body cavities. These tags were obtained from Robert A. Nesbit of the Fish and Wildlife Service and are the type which the Middle Atlantic Fishery Investigational staff is using for tagging fingerling shad.

The specifications for these tags are as follows: length 9/16 inch, width 3/16 inch, thickness 20/1000 inch, made of opaque celluloid (Dupont viscoloid No. 6671 or equal), bright red in color with the ends rounded to semi-circles. Thirty-eight of the fish were marked with larger tags, 1¼ inches long and 5/16 inches wide, but otherwise similar to the small tags. One side of the tag bears the Service name and address, the other the number of the tag, printed in black.

In marking the fish, they were first quieted in 3 percent salt solution. An incision just wide enough to receive the tag was made with a razor-edge scalpel with No. 340 curved blade (see photograph). The curved blade was found more satisfactory than a variety of other types but the tip must be kept very sharp for effective work. In actual practice, the instruments, both scalpel and tweezers, were kept in 70 percent alcohol when not in use. The red tags were inserted with tweezers, the fish again dipped in salt momentarily and released in a pail of fresh water.

The 1,734 bass tagged in this manner on September 25, 1939, were placed in a small pond a quarter of an acre in area. About 100 dead were removed 2 days after tagging, 18 on September 28 and 23 on October 10. The pond was drained on October 31, and 1,247 of the tagged fish removed, showing that 72 percent of the fish survived the tagging process.

In this period of slightly more than a month, the incisions had completely healed. Fourteen specimens were opened and in 5 of these the tags were completely

hidden from view in fat and connective tissue about the folds of the intestine. In the remaining, some portion of the tag was visible.

On November 2, 1939, 690 of these fish were placed in the North Fork of the Shenandoah River between the first bridge below Strasburg, Virginia, and the mouth of Passage Creek, and another lot of 550 were planted in the Shenandoah River between Shepherd's Ford and Castleman's Ferry near Berryville, Virginia.

Only a few returns have been received thus far. The first of these fish was caught July 29, 1940, about 2 miles below the section in which it had been planted. By this time it had attained an over-all length of 10 inches. The second fish was reported on September 21, 1940, from the section stocked on the North Fork of the Shenandoah River. This fish measured 10.5 inches in length. A third report was received this year from the Shenandoah section when a tag was found in a bass 11.5 inches in length on August 13, 1940, at Lock's Mill which is a few miles above the section stocked.

A reward of one dollar was offered for the return of these tags, and notices describing the tags were placed on trees at boat landings in the sections stocked for the first time this year. The results, thus far, have not been encouraging. It may be significant that 2 of the 3 tags returned were of the large type, although only 38 of these were used.

ANGLERS IN TEST STREAM GET BETTER THAN FIVE FISH EACH

Anglers who fished Naysmith Brook, Vt., this season averaged better than five fish each, according to creel records compiled by the Fish and Wildlife Service. During the past two years, this brook, a tributary of Winooski River, has been operated by the Service as a "test" stream, and careful catch records kept of angling experience.

A comparison of the catch for 1940 and 1941 shows that the 1941 catch of 2,239 fish exceeded that of 1940 by 741 fish although there were fewer anglers. Consequently the average catch for 1941 was much better, being 5.3 fish as compared with 3.1 fish for the preceding year. The average catch per fisherman hour was 1.2 fish in 1940 and 2.0 fish in 1941.

As in Furnace Brook, another Service test stream, rainbow trout are doing very well without aid from artificial stocking. This species made up 61.9 percent of the catch in 1940 and 59.4 percent of the catch in 1941.

REPORT SHOWS HIGH RETURN FROM PLANTINGS OF TROUT

A brook or rainbow trout caught every two hours at least--that's the story the records tell of this season's angling in St. Mary River, Va., reports of Fish and Wildlife Service Biologists indicate.

Returns from stocking legal-size brook and rainbow trout two seasons ago have just become available. These reports show an exceptionally high return from the fish planted, 57.3 percent of the brook trout and 21.6 percent of the rainbow trout having been taken by anglers the following summer.

Figure 1. Looking downstream into the seaward-migrant counting weir.

TWO-WAY COUNTING WEIR FOR SALMON

COMPLETE CENSUS OF SALMON MIGRANTS TAKEN IN ALASKA STREAM

DURING THE SUMMER AND FALL of 1940, 53,594 adult pink salmon entered a small stream at Little Port Walter in southeastern Alaska to spawn, and a few months later the seaward migration of their young began. By actual count, 3,402,830 fry survived the numerous hazards of early life and entered the sea to take up the life of adult salmon.

This complete census of a spawning run and of the number of their young that survived to the seaward-migrant stage was made possible when a downstream counting weir was installed last March by biologists of the Fish and Wildlife Service. Adult pink salmon migrating into the streams at Little Port Walter have been counted through an upstream weir each season since 1934, but structures suitable for trapping and counting the young were not available until 1941. Operation of the 2-way counting weir at Little Port Walter through successive seasons will provide information of great importance to biologists studying the rate of survival of young salmon in fresh water. The figures collected will be of interest also to

fish-culturists, who will compare the survival in hatcheries and under natural conditions.

Only 60 feet wide and three-quarters of a mile long, the stream at Little Port Walter nevertheless provides practically every type of spawning ground characteristic of southeastern Alaska, and has been considered an ideal natural laboratory for studying the conditions that affect the spawning and rate of survival of the important pink salmon runs of the region. A laboratory-residence building was constructed during the summer of 1939 so that a year-round biological field station might be maintained (Fig. 2).

Figure 2. The Fish and Wildlife Service's permanent station at Little Port Walter.

The downstream counting weir was installed between March 2 and 9, 1941 by a party of Fish and Wildlife Service biologists consisting of Dr. F. A. Davidson, Samuel Hutchinson, Lawrence Kolloen, and several assistants. Cold weather temporarily retarded the migration of the fry, and the first count was made on the evening of March 9. From that date until May 11 the weir was in continuous operation. The nightly count, at first only a few hundred fish, rose to 21,000 on April 1 and to 505,000 on April 12. The run began to slacken off on April 29 and from that date fell off rapidly until May 7, the end of the run.

The seaward-migrant counting weir (Fig. 1) consists of a series of screens that intercept the fry on their downstream migration and lead them into a trap. Collected from the trap, they are counted and immediately released in the stream below the dam. Upstream from the weir, log floats placed at intervals across the stream support heavy boom chains which prevent brush and drifting logs from washing onto the face of the screens. Downstream from the weir, a stop-log dam helps regulate the flow of water through the screens. (Fig. 3). A gantry crane, mounted on wheels and riding on the dam, carries a chain block and bridle for lowering and raising the stop logs in the dam. The stream empties into salt water approximately one hundred feet beyond the dam.

Figure 3. A stop-log dam helps to regulate the flow of water through the screens.

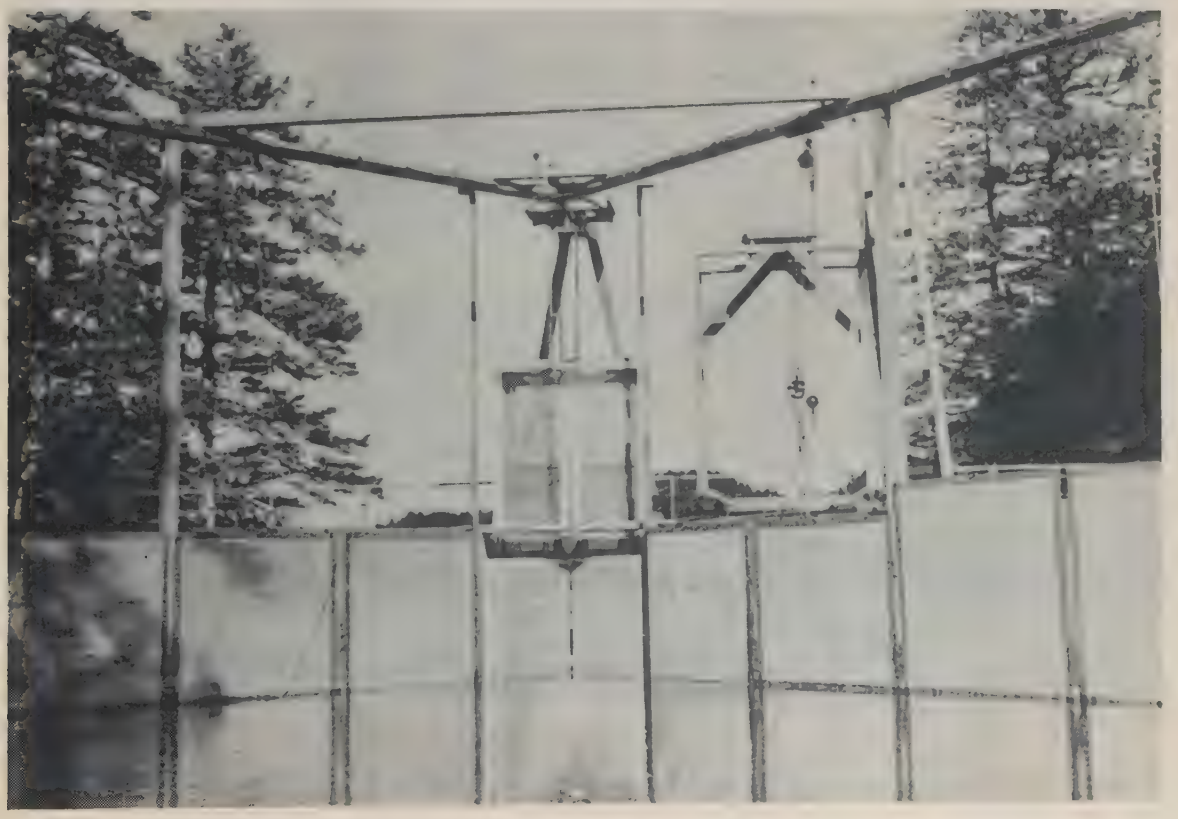

Figure 4. The trap containing the fry is raised by a chain block.

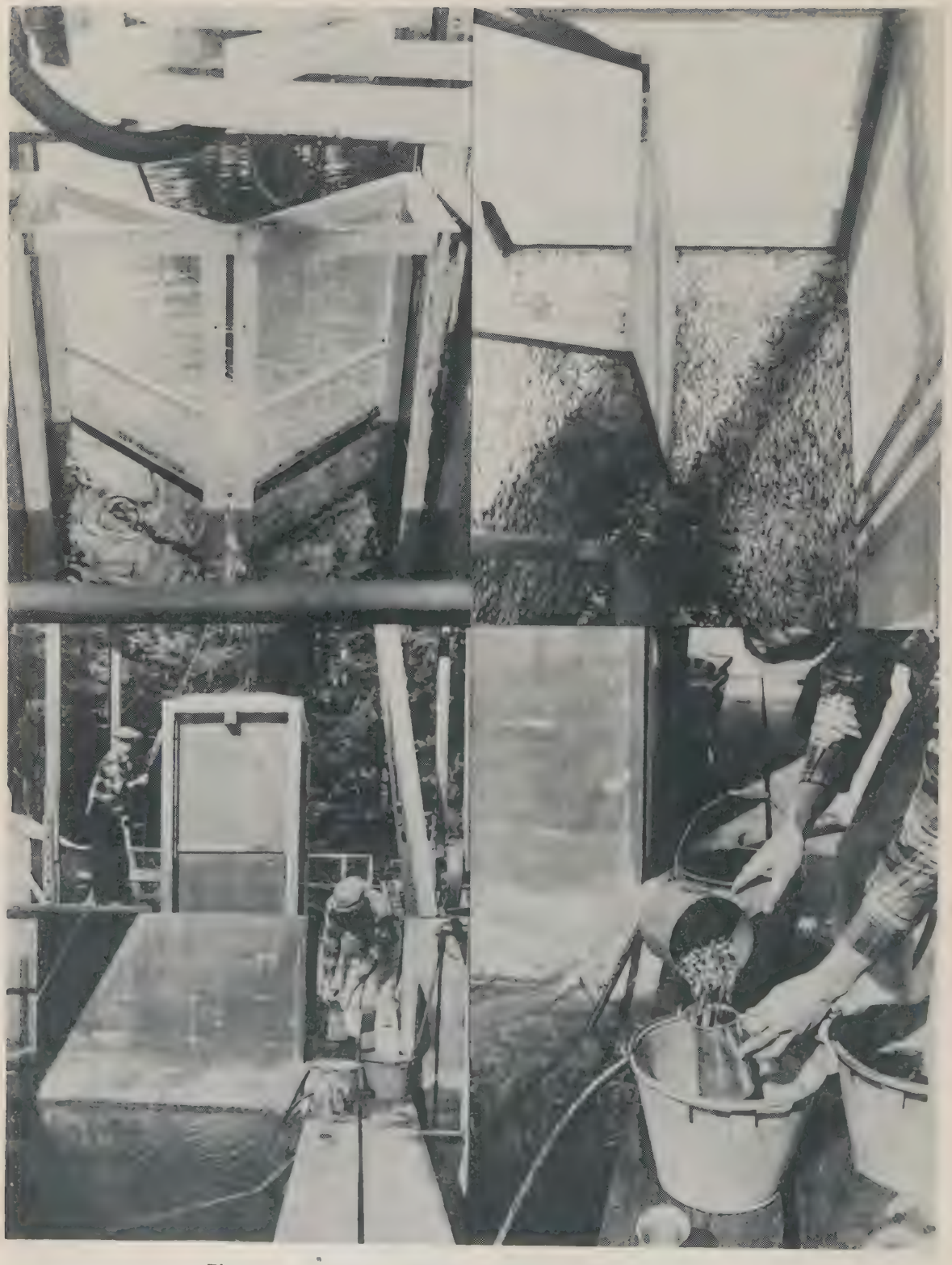

Figure 5. Fry enter the trap through a one-inch slit.
Figure 6. Looking down into the trap, containing hundreds of fry.
Figures 7 and 8. Measuring the fry.

Migration of young pink salmon takes place only at night, and the migrants come downstream tail-first, headed into the current. The young fish are guided along the screens to the throat of the lead, through the middle of which a one-inch slit communicates with a similar slit in the trap. (Fig. 5). The trap fits so snugly against the back of the lead when in the fishing position that the two one-inch slits line up perfectly without any play between them.

The trap, with screen sides and a solid, cone-shaped bottom, is built to retain about 40 gallons of water when raised by the chain block. (Fig. 4). This water, containing the trapped migrants, is then allowed to run out through a 3-inch reinforced rubber hose 9 feet long which is attached to an opening in the bottom of the cone. Figure 6 is a view from the top of the trap looking down into it. The dark area in the middle is the opening to which the rubber hose is attached and through which the fish and water are drawn out of the trap.

In emptying the trap through the hose, the fry are poured into a hatchery bucket with a screen on one side to permit the water to flow out. From the bucket they are poured into a gallon container with perforated bottom and from this into a quart or pint measuring can. (See figures 7, and 8). The full measuring can is then emptied into a bucket containing water. After all the fry in the trap have been measured out, they are released in the stream below the dam. The record of each night's catch is kept in pints. Every other day a pint of fry is counted and the average of these counts is used in calculating the number of fry measured each night.

Facts to be considered in evaluating the percentage of survival are as follows. Although 27,165 male pink salmon and 26,429 females entered the stream, many of the females did not spawn, and many eggs were washed away in the swift current. Therefore, while the figure 58,858,000 represents a maximum estimate of the total egg production, (calculated at 2,000 eggs per female from 26,429 females) there is no doubt that the actual number of eggs deposited was considerably less. Reckoning from this maximum estimate of egg production, however, the migration of 3,402,830 fry means that 6.44 percent of the young survived to the migrant stage.

This percentage of survival may be somewhat lower than normal because of the unusual weather conditions that prevailed during the 1940-41 season. Most of the winter was mild and open and the streams lacked the usual blanket of snow. Late in February the weather turned very cold, the stream level dropped rapidly, and many of the spawning beds were exposed to the extreme cold. R. F. Shuman, foreman of the Little Port Walter station, surveyed the stream during the cold snap and found many nests frozen and containing dead fry. Surveys made later in the spring, while the run was in progress, disclosed the remains of dead fry here and there in the shallow parts of the stream as late as April 24. In some nests the fry had continued to develop after the freeze-up, but were very weak and showed little vitality when dug out of the gravel. Dr. Davidson estimated that at least 20 percent of the total number of fry that had developed up to February 21 succumbed to the cold snap.

Although it is not known how great a mortality the pink salmon sustain while in the ocean, a mortality rate as high as 90 percent would permit 34,000 adults to return to Little Port Walter as spawners in 1942. A run this size would be twice as large as any since 1934, with the single exception of the 1940 run.

FERTILIZING BASS PONDS

LARGE QUANTITIES IN CENTER OF POND RECOMMENDED

By T. F. Nelson
Fish and Wildlife Service
Elephant Butte, N. M.

A GOOD MANY ARTICLES have been written on the various methods of fertilizing rearing and spawning ponds in connection with the propagation of warm water fishes. While all absorb a portion of each article, for the average hatchery man the use of lengthy and technical phrases serves to confuse the interpretation and therefore the article loses a part of its value. Formulas as printed usually are formulas arrived at by use of very small quantities of fertilizer and pond water, without consideration of the many different types of water to be found at the numerous warm water hatcheries.

Some of us at least have been more or less skeptical of the real value of pond fertilizer and of the culture of daphnia or other natural food of the fry, advanced fry and small fingerling fish. Some of us have tried various formulas as found in print, but in most cases the results were not as expected for the simple reason that there is a big difference between water used for preparing the formula and the hatchery water.

The writer was one of the skeptical but was of the opinion that efforts in the line of fertilizing and artificial feeding were worth while. Experiments were carried out at several warm-water hatcheries of the southwest, where the water is not the best and runs above pH 9 , with only a small degree of success. After numerous trials it was questionable if the results were enough to compensate for the effort. Then, being in charge of a station with a very limited pond area the writer was forced to some effort to keep the station production within range of the other stations. Several kinds of fertilizer and several methods were used for two years. The old idea of getting back to nature and staying as close to nature as possible proved the best, and the results have been far beyond expectations.

Cow-lot manure has given the best results. This is not new - perhaps every warm-water hatchery has used it - but the way of introducing it into the ponds is for the most part new. Instead of spreading the fertilizer around the shore line of the pond or on the bottom, it is unloaded in the center of the pond in large quantities. It was believed that if some fertilizer around the shore line was of some benefit,then several times that much fertilizer would be several times as good. This was true in so far as the feed was concerned, but it was found that too much fertilizer in any one place was a nuisance in removing the fry and also produced gases that killed some, and often a good many, fish. The gases from the fertilizer were not liberated into the water in sufficient quantities to be injurious unless disturbed by seining or by high winds.

The problem then appeared to be that of using large quantities of fertilizer without killing the fish. This might be arranged by fertilizing only one side of the pond, next to the prevailing winds. However, as we all know, a bass, bluegill, or crappie is never particular about where it nests and some of them invariably will spawn on the fertilizer. The fry from such nests cannot easily be moved with-

out loosing all or a good part of them. Therefore the method simmered down to dumping large quantities of fertilizer in the center of each pond, far enough from the shore line that there would be little or no danger that the fish would use it as a nest or the workers disturb it while picking up schools of fry or seining fingerlings.

This method has produced a most remarkable amount of feed and the rapid growth of fry to shipping size has been unbelievable. About three tons of fertilizer is used for a one-acre pond or about one ton per acre-foot of water. This amount, however, may vary for other waters. Some may need more fertilizer while others will require less. The water should show a good amber color within 24 hours after the pond has been filled. In order to keep this color and productive condition it may be necessary to add more fertilizer at intervals. This may be determined by daily observation of the ponds. About the middle of the forenoon seems to be the time when the daphnia rise toward the surface of the water. When fertilizer is added after the pond is filled it is necessary to pile or spread the fertilizer near the shore line, but it should be placed in spots that will not be seined over if possible.

The heaps or windrows of fertilizer are removed after each season, as it seems the state of complete decomposition of the fertilizer will be reached during the second season, making it very dangerous to fish. The fertilizer is not wasted as it can be used for building up the soil on the pond banks, improving lawns,gardens, and orchards.

From 100,000 to 150,000 bass fry can be placed in a one-acre pond and reared to a size of 1-1/4 to 1-1/2 inches in a very short time. At this stage cannibalism begins to be noticeable. The fish are then removed for distribution or segregation as to size and are put on artificial food.

NEW SALMON PROJECT IN TULALIP CREEK

Since early in the spring of 1941 the Fish and Wildlife Service has been cooperating with the Tulalip Indian Agency in undertaking to establish a run of coho salmon in Tulalip Creek, a small stream that empties into Puget Sound near Everett, Washington. From recommendations by Dr. James L. Wilding, aquatic biologist, who was assigned by the Service to make a survey of the stream to determine the feasibility of the proposal, it was concluded that the creek should be able to support a population of about 1,000 spawning fish.

The Indian Service recently has completed construction of a fish ladder that will carry the entire normal flow of the creek and provide for the passage of both up- and down-stream migrants. A trap for down-stream migrants was built in the upper part of the ladder. Early in December 30,000 3-inch marked coho salmon fingerlings were liberated in the creek.

Inasmuch as the stream was virgin to salmon, the project furnishes several possibilities for fishery research, including the survival of the two stocks of fish planted in the stream, time of seaward migration, ocean mortality, influence of a known population of fish upon the production and consumption of fish foods, and the determination of the carrying capacity of such a stream through studies of fish growth and space limitations.

NOTES AND NEWS

Protozoan Causes Loss of Walleyed Pike Eggs

DURING LATE APRIL AND EARLY MAY of 1940 an unusual condition accompanied by a high mortality appeared in the walleyed pike eggs being incubated at the Weyauwega hatchery of the Wisconsin Conservation Department, according to a note contributed by Lowell A. Woodbury, a biologist of the Department.

The hatchery is located on the bank of the Waupaca River and part of its water supply is obtained from the river and part from a shallow artesian well. As a result of the use of the river water, organisms of all types occurring in the river may be passed over the eggs.

On April 29, 1940, it was noted that the eggs in the jars began to acquire a coating of dirt and debris and became so heavy that it was difficult to keep them "rolling". Shortly after this date, however, the eggs became fuzzy in appearance and then became so buoyant that difficulty was experienced in keeping them in the jar. This condition continued until the eggs hatched and was accompanied by an increased loss amounting to about 20 percent above the normal.

The eggs were of a dirty brown color and were covered with a coating of long filaments varying in length from one to two egg diameters. Entangled in the filaments was a large amount of dirt, debris, miscellaneous protozoa and other small organisms. Microscopic examination of the filaments showed that they were composed of stalked colonial ciliates belonging to the genus Carchesium. Such extremely large numbers of this protozoan were present on each egg and so much debris was entangled in the stalks that it is believed respiration was curtailed. The death of the eggs was probably due to suffocation.

To prevent a recurrence of the infestation it was recommended that a filter for the river water be constructed. Prior to the hatching season of 1941 a gravel and rock filter was installed around the intake to the river water and the hatching season passed with no repetition of the disease.

Back Numbers of P.F.C. Wanted

THE MAILING LIST of the PROGRESSIVE FISH-CULTURIST continues to grow and with most requests for the journal come requests for previous numbers. While a limited supply of earlier numbers is still on hand and will be distributed to new subscribers, particularly to those having a professional interest in the subject, many numbers are entirely exhausted and complete sets of the journal are unavailable.

All those who have duplicate copies, single back numbers, or sets which they may no longer wish to retain are urgently requested to return them to our stock. Just send a postal card to the Editor, Progressive Fish-Culturist, Fish and Wildlife Service, Washington, D. C., stating the number of copies that can be returned and franked envelopes for mailing them without postage will be sent to you.

Adaptable Box for Handling Fingerlings

ERNEST O. ROGERS of the Fish and Wildlife Service Hatchery at Nashua, N. H. contributes a description of a "floating box" which is used almost continuously at his station for handling fingerlings during the spring and summer.

In making the box one-by eight-inch pine board is used for sides and ends, in any convenient size, with the entire bottom covered with screen or hardware cloth. The ends have a cut-out space as large as can be made without weakening the end, which is also covered with screen. This arrangement provides a circulation of water so that it is possible to hold from 10,000 to 15,000 three-inch fingerlings in a box 3 by 6 feet for considerable time without harm to the fish.

At this station all fish are weighed every 2 weeks and it is necessary to have something which will hold the fish in a particular raceway until all have been removed for weighing. These boxes are adequate for this purpose and are also used for sorting and spawning operations.

Smaller boxes about 18 inches long and an inch narrower than the trough in which they are to be used are in almost constant service at the Nashua Hatchery, according to Mr. Rogers.

"When it is necessary to remove fish from a line of troughs we set two of the floating boxes in the adjoining trough and move the fish across into them which leaves the line entirely empty for scrubbing or any other work that needs to be done. The fish in the boxes float well above the fish in the adjoining trough and will carry any reasonable time without trouble. If disease treatment by dipping is indicated we place the solution in sheet metal tanks a little larger than the boxes. The boxes containing the fish are put into the solution for the required time, after which they can be quickly and cleanly removed by lifting out the box. These boxes also come into use when shipping or transferring fish from one pond or raceway to another. Being built of light lumber they will float about half submerged and with the screen on the bottom the tendency is for the fish to 'go down' so that little or no trouble is experienced from fish jumping."

Fish Counts at Bonneville Dam

COMPLETE COUNTS of the salmon, steelhead trout, and other species passing through the fishways at Bonneville Dam on the Columbia River are now available for 1941, the fourth season of operation. Considering only the steelhead trout and the four species of salmon native to the Columbia, the total count for the year was 668,470 fish. The figures for each of the four years since the completion of the dam may be compared by referring to the table below. It will be seen that the 1941 runs, while substantially larger than those of 1938 and 1939, were somewhat smaller than the runs of 1940. A steady, year-to-year increase in the chinook runs is apparent, and the runs of silver and chum salmon were larger in 1941 than in any of the other years recorded. These increases were counterbalanced, however, by a falling off in the blueback and steelhead trout runs.

COUNTS OF SALMON AND STEELHEAD TROUT AT BONNEVILLE DAM

Year	Chinook	Steelhead	Blueback	Silver	Chum	Total
1938	271,799	107,003	75,040	15,185	2,117	471,144
1939	286,216	121,922	73,382	14,382	1,168	497,070
1940	391,588	197,156	148,805	11,914	1,729	739,172
1941	461,458	118,087	65,743	17,909	5,273	668,470

REVIEWS

RETURN TO THE RIVER, A Story of the Chinook Run

By Roderick L. Haig-Brown
Illustrated by Charles De Feo, $3.00. William Morrow and Company, New York

IN A SERIES OF ARTICLES and lectures on the general subject of "Salmon psychology" the eminent biologist, Dr. Henry B. Ward of the University of Illinois, has insisted that if one is to understand the life and habits and reactions of the Pacific salmon "one must be able to think like a salmon". Probably no better training in learning how to think like a salmon can be obtained by sportsmen, fish culturists or biologists than by reading Haig-Brown's engrossing book RETURN TO THE RIVER.

Although written in the form of a novel depicting with skillful imagery the life narrative of a particular Chinook salmon hatched in the headwaters of an Oregon stream, describing in detail the daily events of the search for food and the escape from enemies, and presenting with eye-witness fidelity the descent to the sea, the life in the ocean and the return to the consummation of all salmon's lives in spawning and final death, the book is far more than another nature tale. It presents with remarkable scientific accuracy the mature observations and the tolerant philosophy of a skilled naturalist who has spent years with his subject in the field, and at the same time has kept up with the most modern developments of an intricate and erudite branch of aquatic biology.

The book is written from the point of view of the salmon herself and of the salmon that accompany the central figure in her wanderings. Man plays, quite properly, an unimportant role in the plot. Sinister though the role usually is, the human characters play their parts in such a reasonable and life-like way that those of us familiar with the Columbia River continually wonder who the Old Senator and the fishery biologist really were in actual life. The casual reader may be wearied by a bewildering array of detail presented in the account of the stream life of young salmon, of their daily foraging for countless insects and other aquatic organisms, of their almost hourly hair-breadth escapes from voracious and cunning enemies. Again, the professional biologist, from the vantage point of his own vast knowledge, may be nettled by the author's failure to distinguish clearly between the solid ground of established fact regarding the life of salmon in the open sea, still very largely beyond the ken of man, and the field of fancy which is an author's prerogative in interpreting and weaving together such facts as we have into a plausable and coherent story. But these are minor criticisms, for the author's interpretations and interpolations are reasonable and necessary to the execution of a masterly job of narration. The illustrations are excellent.

It is gratifying to the reviewer to read a public statement by a layman describing with sympathy and understanding the program of salmon rehabilitation carried out by the Government in connection with the great dams on the Columbia. Particularly is this gratifying in view of the fact that newspaper accounts, since the building of Bonneville, so frequently have garbled the story.

RETURN TO THE RIVER is a worthy companion of Haig-Brown's earlier books: SILVER, THE LIFE OF AN ATLANTIC SALMON, and the two-volume source book, THE WESTERN ANGLER, which was reviewed in an earlier issue of this journal. It is cordially recommended to all lovers of nature, to all fish culturists, and to all who would think like a salmon, to the end that the mighty tribe of Chinook may flourish.

Elmer Higgins

GUIDE TO THE FISHES OF THE GREAT LAKES AND TRIBUTARY WATERS

By Carl L. Hubbs and Karl F. Lagler
Cranbrook Institute of Science, Bull. No. 18, Aug. 1941, 100 pages,
118 figures. Bloomfield Hills, Mich. Paper 50¢; Cloth $1.00

THIS GUIDE IS NOTABLE CHIEFLY for its concise and easily usable keys to the families, genera and species of the Great Lakes drainage. It contains, also, a good drainage map, statements of the general geographic range of each species, together with its occurrence in the Great Lakes area, its chief ecological habitat, and a useful bibliography is appended. No descriptions, beyond the brief diagnostic characters used in the keys, are given. At least a partial compensation for the absence of descriptions is provided by the anatomical illustrations appearing with the keys, and the rather numerous plates offered.

Extended explanations, with illustrations, of the methods of enumerations and measurements, all too frequently omitted in ichthyological work, are given. It is surprising that the authors still used dividers, which must be applied to a graduated ruler, for measuring when several types of vernier calipers are on the market.

The purposes of the guide, namely, to provide brief and ready means for the identification of the fishes of the Great Lakes basin, to show the geographical distribution of each species, and its chief ecological habitat have been well carried out in the brief space utilized. This booklet, no doubt, will be extensively used by both amateurs and specialists. It seems regrettable, however, that its scope was not extended to include habits and ecological relationships.

Samuel F. Hildebrand

UNDER THE SEA-WIND, A Naturalist's Picture of Ocean Life

By Rachel L. Carson
Illustrated by Howard Frech. 316 pages, $3.00. Simon & Schuster, New York

ALTHOUGH THE BOOK, UNDER THE SEA-WIND, lies outside the conventional field of aquatic biology or fishery management of greatest interest to the readers of the PROGRESSIVE FISH-CULTURIST, and somewhat to the embarrassment of the assistant editor of the journal, I believe it entirely proper to call to the attention of our readers a book dealing with a broader field--the shore and sea life of the Atlantic Coast. It is a book of highest merit from both a literary and technical standpoint. Besides that, it is strictly a home product of which the Division of Fishery Biology justly can be proud.

Since its publication in November, 1941, the book has received literally dozens of favorable or enthusiastic reviews and comments by both literary and technical critics, including such men as Beebe, Hubbs, Breder, and Minor, who speak with authority in the field of aquatic biology, and Chapman, Allen, Sutton, and Gilbert Pearson for the field of ornithology. As an interpretive study of the endless struggle for existence in the sea, and written with a simplicity and clarity of style, frequently characterized as "lyrical" in its literary beauty, the book is factually sound, technically accurate, and free from the artificialities and sentiment so often found in nature books of this sort. Beautifully illustrated, it informs painlessly and entertains charmingly. A Scientific Book Club selection.

Elmer Higgins

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